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AUTHOR Barker, Philip; Bartolome, Antonio
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ABSTRACT

The "Hypermedia for Teaching" project is a European collaborative venture designed to produce a hypermedia learning package that is published on CD-ROM. Two versions of the package are to be developed. One of these is intended to be used on a multimedia personal computer (MPC), while the other is to be used in conjunction with commercially available CD-I (compact disc-interactive) equipment. The MPC version of the package is currently being developed, and the CD-I version is being designed. The two versions will share a basic common architecture: the topmost level provides the generic control mechanisms for the system; the second level contains activities modules, either common core (dealing with a particular aspect of hypermedia theory, design, or practice) or application (dealing with the use of hypermedia methods within a particular domain); and the lowest level, documents, which make up the basic building blocks of the overall system. It was discovered that simple book and page structures, backgrounds, fields, graphic objects, and groups could be easily created using the basic set of tools provided by the ToolBook implementation language. The creation of a CD-ROM prototype disc involved four main stages: local testing and emulation; data transportation; building a disc image on magnetic disc; and transferring the disc image to a recordable compact disc using either a single session or multi-session CD recording unit. Several difficulties arose during the project: end-user interface design issues; consistency of treatment, consistency of style, and programming efficiency of scripts, modules and the CD-ROM; and limited resources. (Author/MAS)

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Hypermedia for Teaching - A European Collaborative Venture

Philip Barker
Interactive Systems Research Group
Human-Computer Interaction Laboratory, School of Computing and Mathematics
University of Teesside, United Kingdom

Antonio Bartolome
Departament de Didactica i Organitzacio Escolar
Divisio de Ciencies de l'Educacio
Universitat de Barcelona, Barcelona, Spain

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Abstract: The 'Hypermedia for Teaching' project is a European collaborative venture designed to produce a hypermedia learning package that is published on compact disc read-only-memory (CD-ROM). Two versions of the package are to be developed. One of these is intended to be used on a multimedia personal computer (MPC) while the other is to be used in conjunction with commercially available CD-I (compact disc - interactive) equipment. The MPC version of the package is currently being developed and the CD-I version is being designed. This paper describes the Hypermedia for Teaching project and its current status. It also discusses the logistics and problems of running a large multi-national hypermedia project.

INTRODUCTION

The 'Hypermedia for Teaching' project is a three year research and development project that is funded by the European Community (EC) within its COMETT framework. The project involves a consortium consisting of twelve partners. The partners involved in the project are based in the following countries: Belgium, Denmark, France, Greece, Italy, Portugal, Spain, Sweden and the United Kingdom. The project base is at the University of Barcelona although project meetings are hosted, in turn, by other member countries. The working language for the project is English.

The major objective of the project is to create a collection of hypermedia documents (published on CD-ROM) that can act as an informative and authoritative source of material on hypermedia techniques and their potential uses within a number of different application domains. As well as being of a multi-national nature the project is also required to be multi-lingual in that the materials that are developed must be published (on CD-ROM) in six of the languages of the EC.

The collection of hypermedia documents that is produced will be published on conventional CD-ROM in the first instance -for delivery using a MPC (Jamsa, 1993). Subsequently, they will also be published on optical disc in CD-I format for delivery using a Philips CDI-205 CD Interactive Player. This is a relatively low-cost CD-I delivery platform intended for the consumer market. The reason for publishing the hypermedia documents in two formats is to explore the problems involved in creating hypermedia documents for delivery on multi-platform environments. Currently, no real standards exist -although the EC ESPRIT project OSMOSE (Open Standards for Multimedia Optical Storage Environments) is exploring the problems of defining a common publishing format (DELTA, 1991).

PROJECT DESCRIPTION

This section of the paper briefly describes the Hypermedia for Teaching Project and the progress it has made since its inception in June 1991. The description is organised into four sections: system architecture; implementation notes; CD-ROM prototype production; and problem areas.

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System Architecture

Even though the physical implementations of the two CD-ROM discs described above will be different (as will their end-user interfaces) the basic conceptual architecture (and content) of the two CD products will be very similar. The basic common architecture of the two systems is illustrated schematically in figure 1.

This diagram depicts the three-level structure that makes up the complete 'Hypermedia for Teaching' system. The topmost (Contents) level provides the generic control mechanism for the system - through which users gain access to all the other embedded modules and system functions. Beneath this, at the second level, are the various component modules themselves which together make up the overall system. At the third level is the collection of electronic documents that are used as building blocks in order to construct the higher level modules from which the system is built.

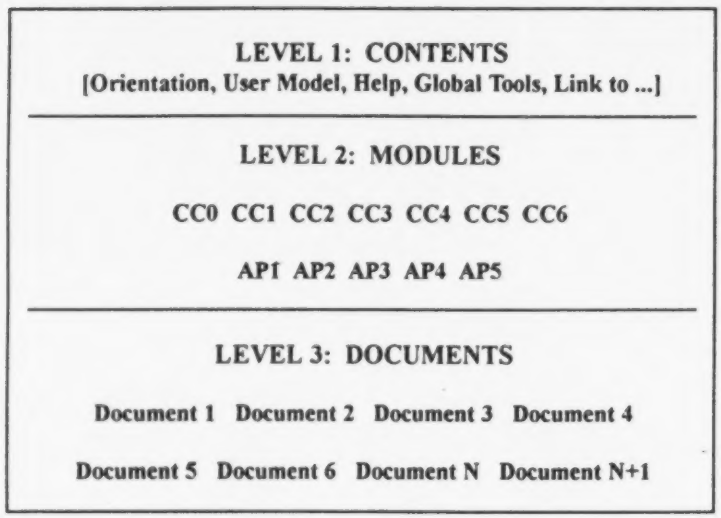
LEVEL 1: CONTENTS
[Orientation, User Model, Help, Global Tools, Link to ...]
LEVEL 2: MODULES
CC0 CC1 CC2 CC3 CC4 CC5 CC6
AP1 AP2 AP3 AP4 AP5
LEVEL 3: DOCUMENTS
Document 1 Document 2 Document 3 Document 4
Document 5 Document 6 Document N Document N+1

Figure 1. Basic Structure of the hypermedia system

The Contents module (see Figure 1) provides the only way by which users can enter the application - even though they might leave from any of the lower level modules once they have gained entry to the system. As well as acting as an overall control and coordination facility, the Contents module provides four other basic functions. First, it provides an optional 'orientation' facility for new users of the system. Second, it embeds a simple user model (based upon two dimensions - type of user and the language that he/she speaks); this can be used to tailor subsequent end-user interaction with the lower-level modules. Third, it provides a toolset of generic functions that users might find useful during their interactive sessions with the system. Fourth, it makes available an extensive multimedia help facility (at the generic system level) about such topics as: how to navigate through the system; facts and figures about the CD-ROM itself; details about the project and its participant groups; and so on.

As mentioned above, one of the major functions of the Contents module is to enable users to access any of the second level modules that make up the application. This is accomplished using a mouse-based dialogue by 'clicking' on one of the reactive buttons that make up a two-page menu facility. The modules at this level of the structure (see Figure 1) are organised into two basic categories. First, a collection of 'Common Core' modules; and second, a series of 'Application' modules. The Common Core modules (of which there are seven) each deal (in a generic way) with a particular aspect of hypermedia theory, design or practice. Similarly, each of the Application modules deals (in an application oriented way) with the use of the hypermedia methods within a particular application domain - such as banking, project management, language teaching, and so on. The complete set of Common Core and Application modules used in the project is listed in table 1.

The electronic documents that exist at the bottom level of the structure shown in figure 1 make up the basic building blocks of the overall system. This collection of documents can be interlinked in various ways to form the Common Core and Applications modules that exist at level two. The electronic documents residing at level three can be classified according to two basic dimensions. First, whether they are of a linear or a non-linear format. Second, whether or not they have a simple of compound structure. Simple documents are ones which do not embed any other document whereas compound documents embed one or more other (linear or non-linear) documents within them. The embedding of documents one within another can take place in either of two ways - directly or indirectly. Direct embedding involves importing one document into the body of another. Indirect embedding involves dynamic linking to other external documents which are therefore not themselves part of the original document's structure. Obviously, there are advantages and disadvantages to each of these approaches.

Table 1
Component Modules of 'Hypermedia for Teaching'

Designation	Topic Treated	Designation	Topic Treated
CC0	Introduction	AP1	Higher Education
CC1	Basic Concepts	AP2	Company Training
CC2	History of Hypertext	AP3	Foreign Language Learning
CC3	Creating Hypertext	AP4	Project Management
CC4	Navigation	AP5	Banking
CC5	Hypermedia		
CC6	Teaching and Learning		

An example of the way in which embedding can take place is illustrated schematically in Figure 2 which shows the range of different documents involved in the creation of Common Core Module 0 (Introduction). This is one of the largest modules in the 'Hypermedia for Teaching' system and is designed to provide users (having no prior experience of hypermedia) with an introduction to this topic. The main hypermedia document that makes up this module is composed from three basic types of entity: a body; a set of supporting external files (containing text, sound, pictures and video material); and the collection of directly/indirectly embedded documents that it uses.

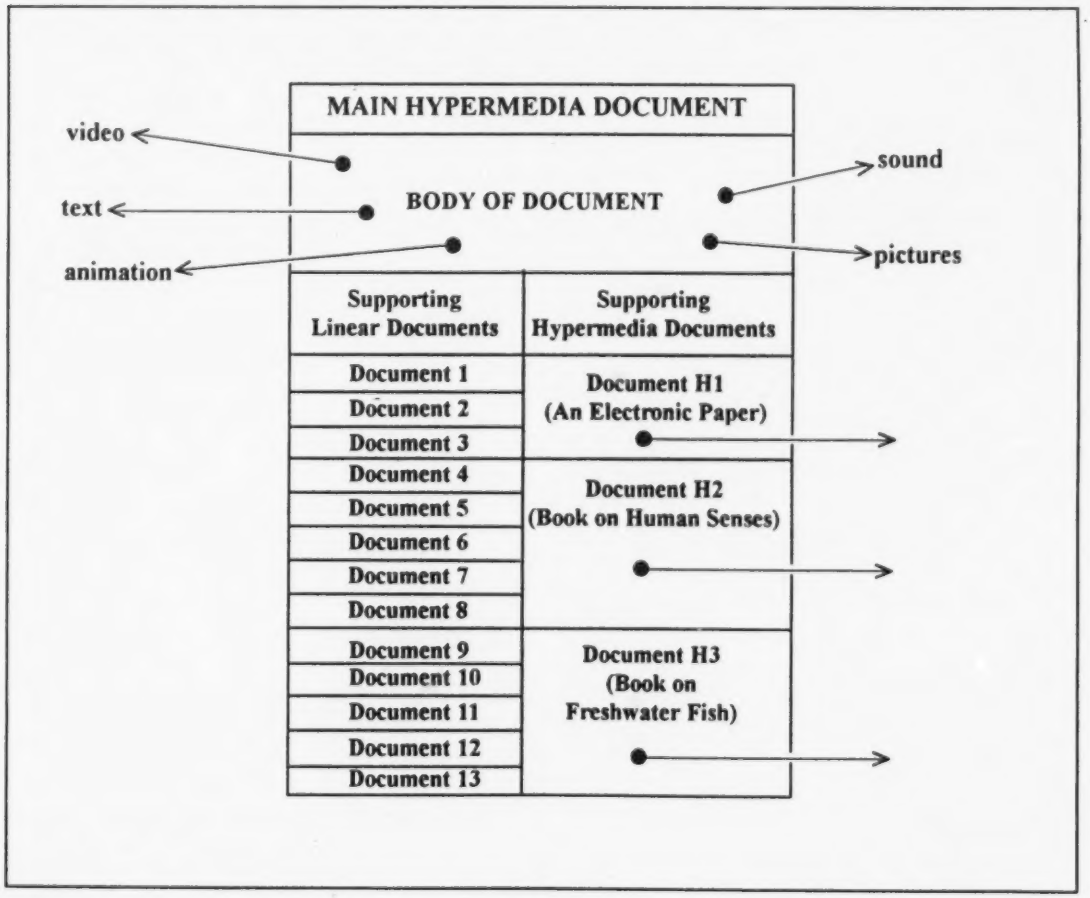

Figure 2. Document types involved in Common Core Module 0

As can be seen from the bottom level of the structure shown in Figure 1, the document body that makes up each hypermedia document is organised in the form of a simple electronic book structure (Barker, 1991). That is, the documents from which the application is composed are regarded as being collections of reactive multimedia and/or hypermedia pages of information upon which are defined various types of operation (such as 'next page', 'previous page', and so on). The operations that are available within any given module will depend upon the types of tool that a particular module needs in order to fulfil its requirements within the overall application.

Implementation Notes

The implementation language choosen for the project was ToolBook (Barker, 1993a). The use of this environment for the implementation of the 'Hypermedia for Teaching' system enabled us to use an object-oriented approach to the design and development of the overall application. We found that simple book and page structures, backgrounds, fields, graphic objects and groups could easily be created using the basic set of tools provided by the ToolBook system. However, some of the more sophisticated object properties and attributes had to be created and controlled using programming techniques. These involved having to generate scripts using the OpenScript programming facility. We also found that most of the simple things that we wanted to do could be easily achieved using the basic ToolBook development environment (Version 1.53) but many of the more complex operations (involving digital sound, animation and motion video) required the use of the multimedia extensions.

The Contents module was implemented as a simple ToolBook book containing just three pages: an introductory page and two menu pages. Each menu page contained two sets of reactive buttons. These were organised into two basic types: local buttons and link buttons. Local buttons could be used to initiate local functions such as page turning, invocation of help facilities, exiting, and so on. In contrast, link buttons were used to invoke the other ToolBook books that existed at the second level of the modular structure illustrated in figure 1. An important component of the Contents module is its multimedia help facility. This is capable of providing help and advice in the form of screen-based text and/or audio narrations. The latter are stored as pre-recorded digital sound files (in WAV format) which are sent (as needed) to the Sound Blaster audio card that is embedded within the host MPC that is being used to deliver the application.

With one exception, all of the Common Core and Application modules were implemented as individual books which were later incorporated and integrated into the complete 'Hypermedia for Teaching' system. In most cases one particular project partner took the responsibility for developing at least one (but sometimes two) of the level two modules. The only exception to this implementation strategy was associated with the Project Management module which, for 'political' reasons was implemented in IconAuthor and subsequently integrated into ToolBook using dynamic linking and object linking and embedding techniques (Jamsa, 1993).

From the point of view of creating hypermedia documents the ToolBook environment undoubtedly provided an exceptionally easy system to use. For example, it was very easy to create new books, backgrounds and pages: and then add text fields, graphical objects, sound effects and reactive buttons to these pages. Buttons were also simple to create (using the button tool) and their reactive properties could then easily be defined by the ToolBook scripting facility. Graphical objects could be created (or imported) and then made reactive by 'pasting' invisible buttons over those areas that were to exhibit reactivity. These reactive areas could then be linked to other pages, to other documents or to other processes. Special effects (visual and audio) could also be created through the design and implementation of appropriate scripts. It was also relatively easy to create reactive words and phrases within text - and then link these up to other pages or objects within the same screen or another book.

Obviously, text handling facilities played an important role with respect to page creation for the hypermedia documents that were used. Invariably, this involved importing text from other applications such as desk-top publishing systems and word-processing packages. In general, no major difficulties were encountered although some minor editing of imported text was usually necessary. We found that two of the most useful features of the ToolBook system (in the context of text handling) were its scrollable text fields and its text searching facilities. The use of scrollable text fields meant that large volumes of hypertext material could be accessed through a relatively small fixed screen area. However, some care had to be taken in following up links from and back to pages containing scrollable fields - in order to avoid loss of context. This problem was overcome by writing a simple script that could 'remember' the context of a scrollable field when one of its embedded hotwords was selected. The Too!Book text searching facility provided a useful mechanism by which end-users could search through hypermedia documents in order to locate particular sections of text that might be of special interest to them.

CD-ROM Prototype Production

The creation of a CD-ROM prototype disc involves a number of fairly well-defined stages (Barker, 1993a). Within this project the four main stages were: local testing and emulation; data transportation; building a disc image on magnetic disc; and transferring the disc image cross to a recordable compact disc using either a single session or a multi-session CD recording unit. Each of these stages is briefly discussed below.

Each project partner was given the responsibility for ensuring that the material submitted for publication was free from errors and coherently organised. In order to realise these objectives it was necessary to use local emulation facilities in order to simulate the behaviour of the modules when committed to compact disc. In many cases this emulation phase involved building the anticipated module structure into re-writable magneto-optical disc storage. In cases where this was not available, hard disc storage had to be used instead.

It was agreed that one project partner (the University of Barcelona) would be responsible for collecting together the modules produced by the different project partners. Various methods of data transportation were therefore used to transfer modules to the Spanish group. In general, three basic techniques were used: tape streamer; exchangeable hard disc units; and conventional 3.5 inch floppy discs containing compressed files that could be decompressed on arrival in Barcelona. Electronic mail facilities were considered but not all partners had access to this type of resource.

At the University of Barcelona all of the materials that were submitted by the project partners had to be extracted from their transportation media and stored in a standard, uniform and appropriately structured way within the host PC that was used to build the CD disc image that would subsequently be transferred to the actual compact disc. Prior to constructing the CD disc image any minor editorial changes (textual, graphical or aesthetic) that were necessary to achieve overall consistency were undertaken.

Once the CD disc image had been created it was transferred across to the CD-ROM recording system (a Philips CDD-521GN Desktop CD-Recorder System) that was attached to the PC that was used for system building. Two basic approaches can be used: single session and multiple session. The first of these involves transferring all of the disc image across to the CD in one single transfer session. The second involves building the CD incrementally over several independent recording sessions. Although our equipment was capable of performing multi-session transfers, we transferred our disc image in one single transfer session.

Problem Areas

Obviously, in a multi-national project such as this one, which involves so many different partners, a number of problem areas will invariably arise. We conclude this section of the paper by summarising some of the difficulties that arose during the project and how they were overcome. For the purpose of the following discussion the problem areas that were encountered are organised into three broad classes: end-user interface design; production issues; and resource implications.

Some of the most interesting problems that we had to resolve were created by end-user interface design issues (Bartolome, 1992). The problems encountered here involved having to decide upon: when to use icons and when to use textual descriptions for control functions; the text fonts and point sizes to be used; the types, style, size and positions of buttons; what tools and facilities should be provided for end-users; when and where to use menu entries and buttons (in situations where a choice was available); and the levels of help that should be provided by the system. All of these problems were eventually resolved after much (often heated) discussion and debate.

Overall, the production of scripts, modules and the CD-ROM proceeded fairly smoothly. However, a number of obstacles did have to be overcome. Three of the most important of these related to: consistency of treatment (with respect to the level and scope of subject matter); consistency of style (that is, ensuring that different modules produced by different partners all had the same style of presentation and a consistent end-user interface); and programming efficiency - partners varied widely with respect to their knowledge of and expertise with ToolBook and OpenScript. Again, these problems were not too difficult to overcome as a result of the free interchange of technical programming knowledge, the creation of an editorial advisory team (whose responsibility was to check the quality of scripts prior to their implementation) and the appointment of a quality assurance officer (who was based at the University of Porto in Portugal).

As is the case with virtually all technology-based projects, the problems arising as a result of limited resources were probably some of the most difficult to overcome. There was a fixed amount of financial resource (in

terms of ECUs) available for the production of the 'Hypermedia for Teaching' discs. This had to cover the costs of equipment, development, translation between European languages, travel and project meetings. Fixed sums were therefore allocated to each one of these expenditure headings. Undoubtedly, the mechanism for dividing up the budget available for module development created one of the most difficult problems to sort out. In the end it was decided that all modules should be allocated equal funding. Obviously, in some cases this created problems with respect to the 'natural closure' of a module and hence its overall size.

Obviously, some problems still remain to be resolved. Two of the most important of these relate to the translation of the overall system into the six selected European languages and the logistics of creating and distributing a multi-lingual system such as this. These problems will be resolved in due course. Despite the problems that have been encountered in this project, overall, it has made good progress and will undoubtedly be successfully completed.

CONCLUSION

Electronic documents are playing an increasingly important role as a mechanism of communication within a wide range of different contexts such as business, commerce, education, consumer services, and so on. In the past most electronic documents contained just text or text augmented with simple images. However, the advent of multimedia and hypermedia technologies (involving the combined use of text, sound, animation and motion video) now means that many more different types of electronic document can be created (Martin, 1990; Barker, 1993b; Richards, 1993). Hypermedia documents are particularly interesting because of the potentially high communication bandwidth that they are able to make available. Of course, such documents are much more difficult to prepare and disseminate (compared with conventional electronic documents) because they can involve many more communication modalities.

Of course, a major problem associated with the creation of hypermedia documents is the problem of closure. That is, trying to draw reasonable and relatively natural boundaries around the content domain of such documents. Because of the principle of inter-relatedness (which states that, in theory, 'everything is related to everything else'), creating natural closure in hypermedia documents is much more difficult than doing so in conventional documents. It is therefore very difficult to answer the basic question 'Is a hypermedia document ever complete?'.

Another important problem associated with the use and sharing of hypermedia documents (particularly, when they are intended for international use) is the difficulties associated with their translation into other languages. We have found that considerable difficulties can arise - even when they are all produced in a common base language (such as English) and then translated into other target languages.

Our experience in this project with MPC and CD-I design and production leads us to believe that a significant problem that will have to be faced in the near future is the problem of agreeing upon a common publication format and delivery platform for hypermedia documents. At present no real internationally agreed upon standards exist in this area -although some groups are actively working on this issue. However, until such standards have been decided upon and implemented it will prove very difficult to exchange hypermedia documents and deliver them on different delivery platforms unless some form of mark-up language (like SGML) is used.

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